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BIOLOGICAL EVALUATION OF WESTERN SPRUCE BUDWORM ON THE CEDAR CITY RANGER DISTRICT, DIXIE NATIONAL FOREST, UTAH--1983

By
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ABSTRACT

During July 1983, aerial surveys of the Dixie National Forest were made to map the progression of the western spruce budworm, Choristoneura occidentalis Freeman. Visible defoliation was categorized as light, moderate or heavy. A total of 15,801 acres was defoliated on the Cedar City District, Dixie National Forest.

Egg mass surveys were conducted on the Cedar City District. Average egg mass densitites were found to be at moderate levels, with predicted defoliation for 1984 to continue at light to moderate levels.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Freeman, continued to defoliate mixed conifer stands on the Cedar City District, Dixie National Forest. Visible defoliation was first observed in 1980 during aerial surveys on 5,000 acres in the Red Creek, Little Creek, and Caddy Creek drainages east of Paragonah, Utah. In 1982 an evaluation (R4-83-3) was made on the Cedar City District. Egg mass surveys were conducted at the head of Bowery Creek, Yankee Meadow, Navajo Lake and in the Cascade Fall Timber Sale. The purpose of this evaluation is to continue to (1) monitor the current situation; (2) discuss projected losses in the future; and (3) provide recommendations for management alternatives for minimizing future losses to the western spruce budworm.

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EXPERIMENT STATION

TECHNICAL INFORMATION

Insect - Western spruce budworm, Choristoneura occidentalis Freeman.

Host - Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. and Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry.

Life History - The western spruce budworm usually develops from egg to adult in 12 months. The moths emerge from pupal cases in August or early September. Females deposit egg masses on the underside of current year needles of host trees in August. Egg masses are oval, light green, and about 1/16 inch long. Eggs hatch in about ten days. Emerging larvae are light green with brown heads and do not feed, but spin silken shelters (hibernacula) in which they remain dormant over winter. Larvae emerge from their winter shelter in the spring, early May to late June, and move to the previous year's foliage where they feed for 7 to 14 days. About the time buds start to swell, larvae leave the old needles, bore into expanding buds, and feed upon the new growth. Larvae are full grown within 30 to 40 days, June to early July. They are 25-32mm long, and have a brown head and body with prominent ivory colored spots. Mature larvae pupate in June and July (Furniss and Carolin, 1977).

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobili.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from top downward after several years of heavy defoliation.

Extent of the Defoliation in 1983 - Defoliation detected during the aerial survey amounted to 15,801 acres on the Cedar City District. The severity of infestation was categorized as light, moderate and heavy. Acres of infestation are:

Year	Light	Moderate	Heavy	Total
1982	80	7,960	3,240	11,280
1983	10,027	5,448	320	15,801

Areas of visible defoliation on the Cedar City District of the Dixie National Forest occurred from the Little Creek Peak to Navajo Lake. These areas of defoliation are shown on Figure 1.

BIOLOGICAL INFORMATION

Relative Abundance of Pest

Methods - Egg mass surveys were conducted in late September to provide an indication of larval densities and corresponding defoliation expected to occur in 1984. Samples were taken from seven plots within four areas of concern (Figure 1). The stands that were selected were currently infested and homogenous as to size, class, and species composition.

Plots were established at random in an area predetermined from photos and maps. At each plot three sample trees were selected and two branches (70 cm. in length) were cut from opposite sides of the midcrown. The sample trees had to meet the following criteria: Douglas-fir; dominant or codominant; 30-50 feet in height; relatively open grown with a full crown; and some budworm feeding evidence, but the tree could not be severely defoliated or top-killed. Each branch was individually bagged in large cloth bags, tied, labeled and transported to a laboratory for examination.

In the laboratory, the branches were measured for length, width and grid area in cm^2. The foliage was then examined under ultraviolet light for budworm egg masses. Needles bearing egg masses were separated in labeled containers and examined under a microscope to determine new, old, or parasitized eggs.

Defoliation predictions for 1984 were determined from the number of new egg masses per square meter of foliage (EM/m^2), as calculated using the following formula:

EM/m^2 = Number of new egg masses ÷ {(Branch Length cm x Branch Width cm)/2 x 10,000 cm^2}

Defoliation predictions for 1984 were also determined from the density of 1983 egg masses, using the following information developed by McKnight et al. (1970):

Egg mass density (EM/m^2)	Predicted defoliation class [a/]
<1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
>34.10	Moderate for "static" infestations Heavy for "increasing" infestations

a/ Defoliation class limits (percent of new growth)
Undetectable = < 5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = > 65 percent

Results and Discussion - Results of the 1983 egg mass and defoliation survey are presented separately for each area. Table 1 lists the surveyed data.

Bowery Creek egg mass data were not taken previously. This area had an average of 18.5 egg masses per plot and a density of 22.1 EM/m^2. Defoliation detected by aerial survey was heavy in 1983 and predicted to be moderate in 1984.

Yankee Meadow was predicted in 1983 to be moderate, and is predicted to remain moderate in 1984. The average egg masses per plot decreased from 24 to 10 and the density also decreased from 19.9 to 13.17 EM/m^2. Defoliation detected by aerial survey was moderate and could decrease slightly in 1984.

Navajo Lake was predicted to have moderate defoliation in 1983. The average egg masses per plot decreased from 12 to 7 in 1983 and the density decreased from 12.0 to 9.6. Aerial detected defoliation was light and is predicted to be light to moderate.

Cascade Fall Timber Sale area was surveyed in 1982 as Strawberry Creek plot II predicting to be light in 1983. The average egg mass per plot increased from 2 to 14.5 and the density increased from 1.9 to 16.69. Defoliation detected by aerial survey was low in 1983 and is predicted to be moderate in 1984.

As heavy defoliation continues, the life and structure of affected trees will deteriorate by the following process:

1. Stems produce less wood.
2. Fewer vegetative buds, flowers, and cones are produced.
3. Parts of the aerial and root structures die.
4. Abnormal budding develops that may deform both crown and stems.
5. Root rots and bark beetles may subsequently infest weakened trees.
6. Whole trees may die.

MANAGEMENT ALTERNATIVES

No Action - With this approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: (a) a lack of foliage to maintain a larval population; (b) unfavorable weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. The following adverse and beneficial effects of the outbreak would have to be accepted:

1. This alternative would not be effective in preventing additional tree damage. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damage resulting from the western spruce budworm in Utah is not completely known, damage similar to those estimated for the Pacific Northwest could occur if the outbreak continues unabated (Parker 1979). Resultant damage occurring over a typical 10 to 15-year outbreak include the following:

Tree damage	Maximum loss (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Topkilling	25
Cone crop reduction	90+
Christmas tree-use reduction	90+

2. There would be no direct costs associated with selection of this alternative, although timber values will be affected and revenues reduced when severely damaged stands are harvested. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would continue if this alternative were selected.

Silvicultural Management - The main objective of this alternative is to promote effective timber management of the mixed-conifer type to reduce the impact of the western spruce budworm and other forest pests. Thus, stand conditions that reduce tree damages over the long term are created. For example, prescriptions should: (a) open up stands by logging, thinning, and burning; (b) maintain stand densities favoring spruce and aspen; (c) regenerate stands by artificial means, using spruce and pine stock, if suitable; and (d) favor evenaged stands.

Effects of this alternative are:

1. The trend of the current outbreak would not be changed if a silvicultural program was initiated. Tree damages would be similar to those listed under the "No Action" alternative; however, topkilling and mortality to understory regeneration could be reduced in areas entered during the current outbreak.

2. Visual qualities and economic and social impacts would continue if this alternative were selected.

Direct Suppression - Aerial application of a pesticide registered by the U.S. Environmental Protection Agency (EPA) could be made to suppress all or part of the outbreak on the Forest. However, if only part of the infestation is treated or if adjoining lands are not treated, one or two additional treatments may be required during the infestation cycle since treated stands could be reinfested from nearby untreated areas or a population resurgence within the treated area. Application would be carefully timed to the development of the larvae and bud flush; i.e., when 20 percent of the larvae are in the fifth and sixth instars and buds are 85 to 90 percent flushed. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. If a direct suppression program were to be carried out on the Forest in 1984, tree damages and losses could be reduced in areas where permanent tree damages have not yet occurred. However, once permanent tree damages have occurred, the direct suppression alternative may no longer be practical.

2. Although there would be immediate costs associated with the application of a pesticide, positive benefits could be achieved by preventing additional effects to timber and recreational activities.

3. Adverse environmental effects resulting from the application of a pesticide would be minimal and temporary.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West for a minimum of 3-4 years. Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. This insecticide was successfully used against the budworm on the Boise National Forest in 1979.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the western budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Microbial Insecticides

Microbial insecticides such as Bacillus thuringiensis Berliner (B.t), a bacterium, and viruses need further testing and field evaluation before they are ready for use. In 1981, two B. t. formulations were pilot tested by the USDA Forest Service and New Mexico Departments of Agriculture and Natural Resources near Eagle Nest, New Mexico. Preliminary results show that larval mortality was greater in sprayed areas than in check blocks. If treatment is necessary, B.t. could be used in sensitive areas, such as along waterways and near lakes and near specific wildlife areas.

Treatment of High-Value Trees - In recreation areas, VIS centers, and other areas where defoliation of high-value trees would be unacceptable, individual or small groups of budworm-infested trees could be treated by a ground application of an EPA-registered insecticide to reduce the larval density and prevent the adverse effects of defoliation.

Effects of this alternative are:

1. Because only selected high-value trees within an infestation would be treated, this would require annual applications during the outbreak cycle, since treated trees would be reinfested from the nearby infestation.

2. Application costs associated with this alternative would have to be accepted.

3. Adverse environmental effects would be minimal and temporary.

RECOMMENDATIONS

Management of the Current Western Spruce Budworm Outbreak - Recommendations for managing the western spruce budworm are based on the age, extent, and intensity of the current outbreak. In the past 4 years, the outbreak has caused scattered, light-to-moderate defoliation with some patches of heavy defoliation on the District. The current outbreak will continue to cause defoliation in 1984, subsequent unacceptable losses due to growth reduction, topkill and mortality, may accrue. Tree mortality over the course of the outbreak will probably be less than 15 percent. Since the primary function of the affected area is recreation/aesthetics, losses from the current outbreak may be acceptable versus the cost of suppression. The outbreak should be monitored each year to determine extent and intensity. If losses become unacceptable to management in subsequent years, suppression activities can be initiated.

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TABLE 1: EGG MASS SURVEY AND PREDICTED DEFOLIATION FOR CEDAR CITY DISTRICT, DIXIE NF, UTAH 1983

	PLOT #	BRANCH 1	BRANCH 2	BRANCH 3	BRANCH 4	BRANCH 5	BRANCH 6	AVERAGE EM/m^2	EGG MASS/ PLOT	Predicted DEFOLIATION for 1984
Bowery Creek	1	40.81	38.09	0	38.09	0	41.56	26.43	23	Moderate
Bowery Creek	2	45.71	8.16	28.57	9.52	5.19	17.58	17.76	14	Moderate
							Average:	22.1	18.5	Moderate
Yankee Meadow	3	7.69	8.79	0	18.46	24.49	19.61	13.17	10	Moderate
							Average:	13.7	10	Moderate
Navajo Lake	4	8.16	17.14	0	0	0	9.52	5.80	5	Light
Navajo Lake	5	21.43	19.05	7.14	22.86	0	9.52	13.33	9	Moderate
							Average:	9.6	7	Light-Moderate
Cascade Fall Timber Sale	6	6.35	14.29	19.05	4.08	5.19	6.35	9.22	9	Moderate
Cascade Fall Timber Sale	7	50.00	35.71	14.29	35.70	0	8.16	23.98	20	Moderate
							Average:	16.61	14.5	Moderate

Species Sampled: Douglas Fir
EM: Egg Mass
M^2: Meter Squared of Foliage

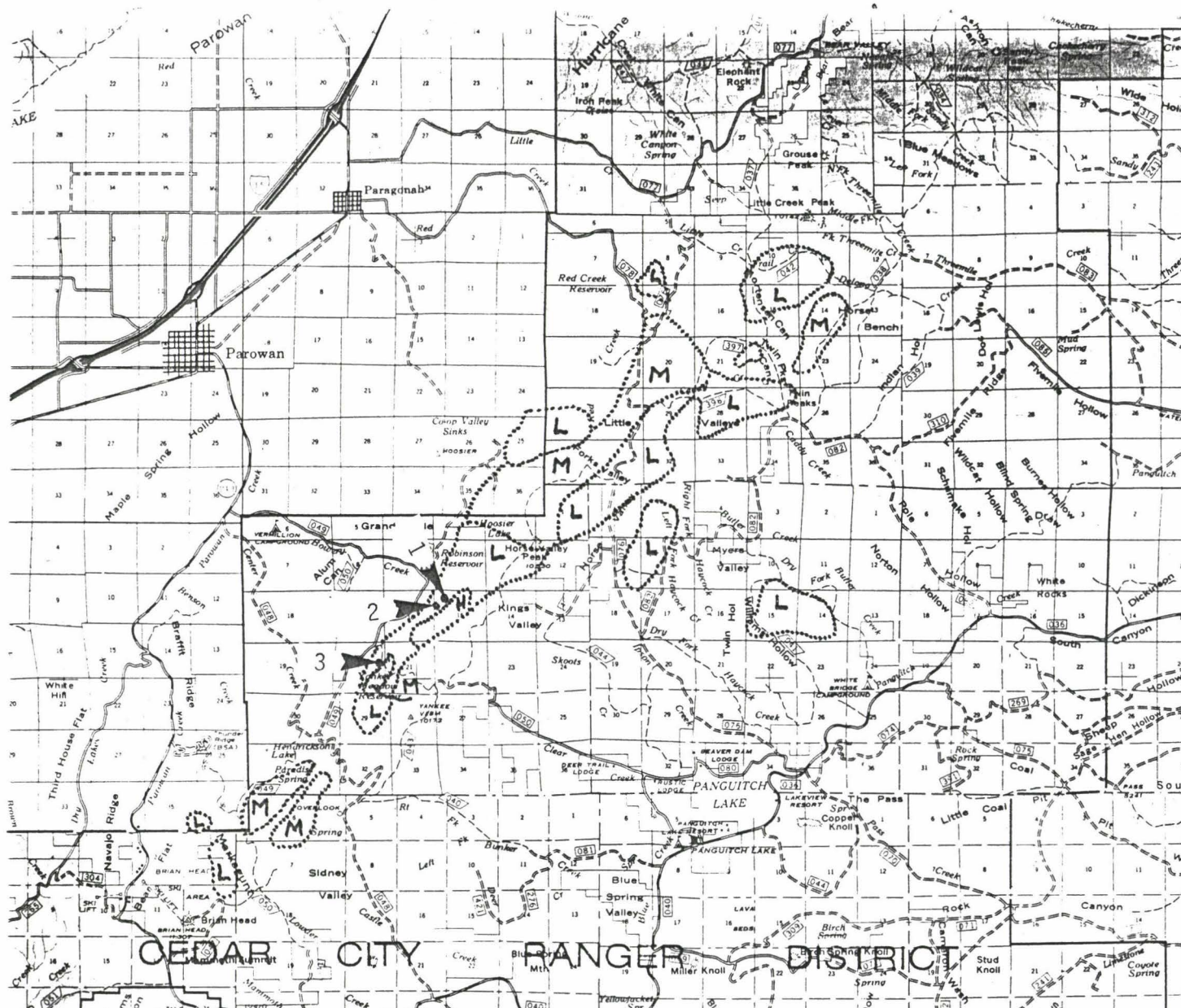

Figure 1. Western Budworm on the Cedar City Ranger District, Dixie National Forest, 1983.

1 Plot number and location.

Areas of defoliation detected by aerial survey.

M Severity of defoliation.
L: Light M: Moderate H: Heavy